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# A MONOGRAPH OF THE NORTH AMERICAN *USNEACEÆ.*

BY R. HEBER HOWE, JR.

## PART I.

It is my purpose to issue in parts a monograph of the North American *Usneaceæ.* The work will embody the results of my studies of the family which have extended over a period of nearly ten years. These studies have been made afield in all the distributional zones of our area, and with the aid of many important herbaria in both this country and Europe. It is hoped this work will supply a manual for future research in this most difficult[1] and interesting family of plants.

### CLASSIFICATION.

In my paper on the Classification de la Famille des *Usneaceæ* dans l'Amerique du Nord (Thèses présentées a la Faculté des Sciences de l'Université de Paris pour obtenir le titre de Docteur de l'Université, Série 60, ordre 71, 1-32: 1912; and Mycologia, **4**: 152-153. 1912) will be found a complete study of the taxonomy of this family, which I have followed here with only a few minor changes. Below is given the working hypothesis on which this classification is based.

Division:

THALLOPHYTES.

Origin.

(Symbiotic)

**Subdivision: (*a*) Composition of the thallus.**

**Class: (*a*) Method of spore production.**

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[1] Harmand, Lich., France, 372. 1907.

Subclass: (*a*) Condition of the mycelium. (*b*) Distribution of the gonidia.

Order: (*a*) Type of apothecia.

Suborder: (*a*) General form of apothecia. (*b*) Development of spores.

Group: (*a*) General form of the thallus. (*b*) Habit of growth—attachment.

Family: (*a*) Form of thallus. (*b*) Structure of apothecia. (*c*) Type of gonidia.

Tribe: (*a*) Type of cortical structure. (*b*) Type of medulla.

Genus: (*a*) Structure of the thallus. (*b*) Type of spore. (*c*) Form of apothecial margin.

Section: (*a*) Number. (*b*) Form. (*c*) Color of the spores.

Series: (*a*) Peculiarities of thalline structure.

Species: (*a*) Differentiation of the thallus or spores.

Variety: (*a*) Constant morphological variation of the thallus or spores.

Phase: (Without name) (*a*) Type of reproduction. (*b*) Color —dicroic. (*c*) Contingent conditions.

The genera that here constitute the Family *Usneaceæ* have been assembled under groups variously titled and of widely varying generic composition. First included (plus p.) in Linneus' *Filamentosi,* they have appeared since under *Ramalodei, Thamnoblasteæ, Parmeliaceæ, Radiatæ,* etc. The grouping of the present genera has caused, except in the case of *Teloschistes,* but slight taxonomic dislocation. The main question for argument seems to lie in whether the grouping of genera had best follow phylogenetic indications supplied by spore characters[2] or by thalline affinities. *Teloschistes flavicans* var. *capensis* (L. fil) Nyl. certainly argues a close thalline relation in this recently introduced genus, and it is interesting to note that Hoffmann called this a species under the name *Usnea capensis.* (See diagram.)

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[2] See Hue, Bull. Soc. Bot. France **58** : 1911.

## GYMNOCARPALES

| Simple Spores | Bilocular Spores | Polari-locular Spores | Pluri-locular Spores | Muriform Spores | | |
|---|---|---|---|---|---|---|
| Usnea<br>Letharia<br>Dufourea<br>Coelocaulon<br>Alectoria<br>Cetraria<br>Thamnolia?<br>Siphula?<br>} lecanorine | Ramalina<br>lecanorine | Teloschistes<br>lecanorine | Roccella<br>Schizopelte<br>Combea<br>Dendrographa<br>} lecidiene | Oropogon<br>lecanorine | Radiatæ | (Filamentose)<br>Fruticose |
| Cladonia<br>Philophorus<br>lecidiene | | | Stereocaulon<br>lecidiene | | Stratosi<br>Radiatæ | |
| | Anaptychia<br>Pseudophyscia<br>lecanorine | | | | Substratosæ | Foliose<br>(Squamose) |
| Platysma<br>Evernia<br>Parmelia<br>} lecanorine<br>Gyrophora lecidiene<br>etc. | Parmelia<br>Pyxine<br>Physcia<br>} lecanorine<br>etc. | Xanthoria<br>lecanorine<br>etc.<br>Placodium | Peltigera<br>Sticta<br>} lecanorine<br>etc. | Umbilicaria<br>lecanorine<br>etc. | Stratosæ | |
| Lecanora<br>lecanorine<br>Lecidea<br>lecidiene<br>etc. | Rinodina<br>lecanorine<br>Buellia<br>lecidiene<br>etc. | Placodium<br>lecanorine<br>etc. | Bilimbia<br>lecidiene<br>etc. | Rhizocarpon<br>lecidiene<br>etc. | | Crustose |

Phylogenetic development

Thalline development

It has been recently well said that "reproduction by spores plainly decreased greatly when the symbiotic relationship was taken on, and the result has in all probability been a considerable physiological degeneration of the spores in the course of phylogenetic development." The lichens, unlike the fungi, have other methods of reproduction, and we must not lay too much stress on the structures of the largely abortive fruit when after all it is the thallus of a lichen that is unique,—and we are considering the classification of them and not of true fungi.

In the present classification the thalline method has been followed. This should not blind one to the fact that the radial *Teloschistes* have undoubtedly their closest phylogenetic relatives (as indicated by the spore) in the polari-bilocular *Xanthorias, Placodiums,* etc. Throughout this classification the fruit characters are given the first *(Gymnocarpales)* and large importance,—but as in the *Phanerogams* their *protophytic* characters are not employed. Phylogenetically, probably, *Usnea* and *Ramalina, Alectoria* and *Oropogon,* are distinct, yet it seems hardly wise to separate these radial and lecanorine genera. The inclusion of *Teloschistes* by M. Hue has been an innovation, rather than illogical. To introduce into the family, as the thalline extremists have done, the lecidiene genus *Roccella* would be a vastly greater step;—contradictory to the apothecial, as their inclusion with the *Graphidineæ* has been to thalline affiliation. Medio tutissimus ibis.

## CHEMICAL CONSIDERATIONS.

This family has been shown, particularly by the late Dr. W. Zopf,[3] to produce several lichen acids. These have been used as aids in classification, though for them can be claimed comparatively little practical value. The following varieties have been attributed to the *Usneaceæ*:

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[3] Die Flechtenstoffe, 1907.

| *Usnea* | *Letharia* | *Ramalina* | *Thamnolia* | *Coelocaulon* |
|---|---|---|---|---|
| Usnaric acid<br>Barbatinic acid<br>Plicatic acid<br>Hirtinic acid<br>Hirtellinic acid<br>Pikrusnidic acid<br>Usnellinic acid<br>Dextrousrinic acid | Usniric acid<br>Vulpinic acid<br>Atranoric acid<br>Divaricatic acid | Usniric acid<br>Ramalic acid<br>Ramalinic acid<br>Evernic acid<br>Scopuleric acid<br>Salazinic acid<br>Atranoric acid | Thamnolic acid | Protolichesterin acid |

| *Cetraria* | *Alectoria* | *Teloschistes* |
|---|---|---|
| Usniric acid<br>Protolichesterin acid<br>Fumar-Protocetraric acid<br>Paralichesterin acid | Barbatinic acid<br>Atranoric acid<br>Laevonsuinic acid<br>Alectoric acid<br>Bryopogoric acid<br>Psoromic acid | Parietin acid |

The question of the value of chemical tests has long been one of contention, though, undoubtedly, they may often be helpful. When, as in the case of *Ramalina sub-*

*farinacea,* they are unaccompanied by marked morphological or structural differences, it seems decidedly unwise to employ them alone for the establishment of species. If the tests be made under the microscope, it will be seen at once that only those with iodine affect the actual lichen tissue—the others affecting only excreted or extraneous matter. Though the former can be considered perhaps a part of the lichen, as much as the waxy excretion of the phanerogamic glaucous leaf, yet it is hardly an important structural indication of differentiation. Again, it is well-known that certain lichen acids which are the cause of these color reactions (potash with atranoric acid, etc.), are developed occasionally only in young thalli growing on certain substrata (i. e., *Xanthorina parietina* on sandstone), and such "considerations should make one very wary in placing reliance on these color reactions for the purposes of classification."

## SYNONYMY.

As the complete and accurate synonymy of a large number of lichens is impossible to compile (l. c. 6), a comparison of all types being necessary, I am giving here only the "name finding" synonymy and any other titles which have been used to designate the species in North American works. These I have included only when absolutely sure of their synonymous character.

## NOMENCLATURE.

The International Botanical Code has been followed. I have indicated, however, the type species of each genus. No forms, states or phases are recognized by title. Much lichenological nomenclature can hardly be termed binomial.

## TYPE MATERIAL.

One of the most important portions of my work on this family has been the investigation of types, photographs of which accompany the species here described. In my former papers on the genera *Usnea,*[4] *Evernia,*[5] *Alectoria*[6] and *Oropogon,*[7] will be found a complete history of the type specimens, augmented by a few special papers (Bull. Torr. Bot. Club **37**: 605-609. 1910 and l. c.), including a report on the Linnean Herbarium (Bull. Torr. Bot. Club **38**: 199-203. 1912). It has been only through the great kindness and generosity of the curators of the herbaria of both this country and Europe that this knowledge, which I consider vital, has been gained. Below is given the list of authors, museums and their curators, to whom I am gratefully indebted.

ACHARIUS: Universitetets Botaniska Institution, Helsingfors, Finland—Dr. Fred. Elfving. Linnean Society of London, Burlington House, London, England—Dr. B. Daydon Jackson.

ANZI: British Museum of Natural History, London, England—Dr. A. B. Rendle. Museum d'histoire naturelle, Paris, France—Dr. L. A. Mangin.

BELLARDI: Istituto ed Orto Botanico della R. Universita, Turin, Italy—Dr. O. Mattirolo.

COSSON: Museum d'histoire naturelle, Paris, France—Dr. E. Perrier.

CROMBIE: British Museum (Natural History), London, England—Dr. A. B. Rendle.

DE NOTARIS: Istituto e orto Botanico, Rome, Italy—Dr. R. Pirotta.

DILLENIUS: Botanic Gardens, Oxford, England—Dr. S. H. Vines.

DUBY: Universitets Botaniska Institution, Upsala, Sweden—Dr. H. O. Juel.

EHRHART: Royal Botanic Gardens, Kew, London, England—Col. D. Prain. Linnean Society of London, Burlington House, London, England—Dr. B. D. Jackson.

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[4] A Manual of the Genus *Usnea*, as represented in North and Middle America, north of the 15th parallel. Bull. Torr. Bot. Club **37** : 1–18. 1910.

[5] The Genus *Evernia* as represented in North and Middle America. Bot. Gazette **51** : 431–442. 1911.

[6] American Species of *Alectoria* occurring north of the 15th parallel. Mycologia **3** : 106–150. 1911.

[7] Mycologia **4** : 152–156. 1912.

**Fée**: Botanisches Institut, Strassburg, Germany—Dr. H. Kniep. Museu Nacional do Rio de Janeiro, Brazil, So. Amer.—Dr. Neves Armond.

**Fries, E.**: Universitets Botaniska Institution, Upsala, Sweden—Dr. H. O. Juel.

**Fries, Th.**: Universitets Botaniska Institution, Upsala, Sweden—Dr. H. O. Juel.

**Hebbe**: Leland Stanford Jr. University—Mr. J. McMurphy.

**Hooker**: Royal Botanic Gardens, Kew, London, England—Col. D. Prain.

**Lenormand**: Institut Botanique, Caen, France—Dr. O. Lignier.

**Linneus**: Linnean Society of London, Burlington House, London, England—Dr. B. D. Jackson.

**Muller**—Arg.: Herbier Boissier, Chambésy, Switzerland—Dr. G. Beauverd.

**Noehden**: British Museum (Natural History), London, England—Dr. A. B. Rendle.

**Norrlin**: Museum d'histoire naturelle, Paris, France—Dr. L. A. Mangin.

**Nylander**: Universitetets Botaniska Institution, Helsingfors, Finland—Dr. Fred. Elfving. Museum d'histoire naturelle, Paris, France—Dr. Mangin.

**Persoon**: 'S Rijks Herbarium, Leiden, Holland—Dr. W. J. Longmans.

**Retzius**: Botaniska Institutionen, Lund, Sweden—Dr. O. R. Holmberg.

**Schreber**: Kgl. pflanzenphysiologisches Institut, Munich, Germany—Dr. O. Renner.

**Stizenberg**: U. S. National Museum, Washington, D. C., U. S. A.—Drs. J. N. Rose and W. R. Maxon.

**Swartz**: Riksmuseets Botaniska Afdelning, Stockholm, Sweden—Dr. C. A. M. Lindman.

**Taylor**: Boston Society of Natural History, Boston, Mass., U. S. A.—Mr. C. W. Johnson. Royal Botanic Gardens, Kew, London, England—Col. D. Prain.

**Tuckerman**: Botanic Museum, Cambridge, Mass., U. S. A.—Dr. W. G. Farlow. Sprague Herbarium, Boston Society of Natural History, Boston, Mass., U. S. A.—Mr. C. W. Johnson.

**Villars**: Museum Ville de Grenoble, Grenoble, France—Dr. M. Mirande.

### ORIGINAL DESCRIPTIONS.

The original descriptions are always given, and have in all cases been copied from the original work. It seems desirable, considering their varied sources, to bring them here under one cover.

### FIGURES.

The references refer to the plates which accompanied the original descriptions. If no plate was published with the original description to the earliest figure following the publication of the name. Of the Linnean species the Dillenian plate is always cited in brackets, as they were invariably referred to by Linneus, and represent his conception.

The present work is illustrated with half-tones of the type specimens, if found still preserved in herbaria. All the plates heretofore published in connection with my former articles are again reproduced with the kind permission of the editors of the Bulletin of the Torrey Botanical Club, Botanical Gazette, Mycologia, Prof. Bruce Fink, and M. Bonnier of the Sorbonne, Paris.

### KEYS.

The keys, it is hoped, will be valuable, augmented as they are by the classification, and the diagnoses for each species and variety. Even the best and most logical keys are to the author's mind, however, never as satisfactory as brief italicized diagnoses, which have been based as far as possible on external features.

### DESCRIPTIONS.

The descriptions have been compiled to allow comparison. The plants of a genus are always treated under definite captions, *i. e.*, thallus, cortex, lacinia or primary and secondary branches, fibrils, apothecia, spores, etc.

### DISTRIBUTION.

As I have already stated the distribution in North America of the species of this family follow to a marked degree the

Life Zones of which a map is given. This is due, no doubt, to the fact that they are not (or little) dependent on soil conditions. In giving the distribution I have, however, not only stated political and altitudinal limits as far as possible, but a diagram accompanies each species.

## SUBSTRATA.

Though in my own herbarium labels I have indicated whenever possible the exact character of the substratum, and this method has also been followed in many of the modern herbaria examined, yet it does not seem either practical or particularly valuable to list minutely the substrata for lichen species. I have therefore employed the following general terms: coniferous or deciduous trees; dead timber—fallen trees, etc.; old wood—fence rails, roofs, etc.; stones, boulders and ground, including actual soil. The question of exposure is also important. My observations go to prove that strongly lighted or sunny exposures generally produce the fruited (apothecial) conditions, whereas sorediate or soraliate phases are found most commonly in shaded or humid places. Yellow lichens are almost invariably sunlight species, which their color may explain (l. c. 26). Rigid types are frequently maritime.

## HERBARIA.

Below is given a list of Herbaria I have examined with the names of the curators, to whom I am gratefully indebted. It has been absolutely necessary in such a variable family to examine an enormous amount of material. It is only by so doing that one can judge the true value of species and varieties. In two of my former papers on the genera, I gave lists of all material examined; such a procedure, though of distinct value is, nevertheless, impractical in the present extended work.

U. S. National Museum, Washington, D. C.—Drs. J. N. Rose and W. R. Maxon.

Academy Natural Sciences, Philadelphia, Pa.—Dr. S. Brown.

New York Botanical Gardens, New York, N. Y.—Dr. N. L. Britton.

Wellesley College, Wellesley, Mass.—Dr. L. W. Riddle.

Prof. Bruce Fink's, Miami University, Oxford, Ohio.

Portland Society of Natural History, Portland, Me.—Mr. A. H. Norton.

Sprague, Boston Society of Natural History, Boston, Mass.—Mr. C. W. Johnson.

Cummings, Wellesley College, Wellesley, Mass.—Dr. L. W. Riddle.

Boston Society of Natural History, Boston, Mass.—Mr. C. W. Johnson.

Dr. L. W. Riddle's, Wellesley, Mass.

Sullivant Moss Chapter, Washington, D. C.—Miss M. F. Milier.

University of Maine, Orono, Me.—Dr. Mintin A. Chrysler.

Williams College, Williamstown, Mass.—Dr. S. F. Clarke.

Sheffield Scientific School, New Haven, Conn.—Dr. A. W. Evans.

Johns Hopkins University, Baltimore, Md.—Dr. D. S. Johnson.

Taylor, Boston Society of Natural History, Boston, Mass.—Mr. C. W. Johnson.

Dr. H. E. Hasse's, Sawtelle, California.

Mr. C. C. Plitt's, Baltimore, Md.

Carnegie Museum, Pittsburg, Pa.—Dr. O. E. Jennings.

Brown University, Providence, R. I.—Dr. J. F. Collins.

Canadian Geological Survey, Ottawa, Canada—Prof. John Macoun.

Dr. A. C. Herre's, Oakland, California.

Cosson, Museum d'histoire naturelle, Paris, France.—Dr. E. Perrier.

British Museum (Natural History), London, England—Dr. A. B. Rendle.

Museum d'histoire naturelle, Paris, France—Dr. L. A. Mangin.

Montagne, Museum d'histoire naturelle, Paris, France—Dr. L. A. Mangin.

Royal Botanic Gardens, Kew, London, England—Col. D. Prain.

Linnean, Burlington House, London, England—Dr. B. Daydon Jackson.

Dillenian, Botanic Gardens, Oxford, England—Dr. S. H. Vines.

Acharian (in p.), Burlington House, London, England—Dr. B. Daydon Jackson.

Smith, Burlington House, London, England—Dr. B. Daydon Jackson.

## EXSICCATI.

Under each species I am citing all examples published in North American exsiccati. Below is given the list of exsiccati examined of both North America and European distribution:

Canadian Lichens, prepared by John Macoun, 18—

Lichenes Boreali-Americani, Cummings, Williams, Seymour, 1894-1899.
Decades North American Lichens, Cummings, 1899-1903.
Lichenes Exsiccati, Mr. G. K. Merrill, 1909—
Lichenes Nova Angliæ, Howe, 1909-10.
Kryptogamæ Exsiccati, Dr. A. Zahlbruckner, 1894—
Lichenes Rariores Exsiccati, Dr. A. Zahlbruckner, 1902-04.
Lichenes Rariores Veneti, Anzi, 1863.
Lichenes Etruriæ Rariores Exsiccati, Anzi, 1863.
Lichenes Sueciæ Exsiccati, E. Fries, 1818-1827.
Lichenes Americæ septentrionalis Exsiccati, Tuckerman, 1847-1854.
Mexican Lichens, Pringle, 18—
Lichens of Eastern North America, Small, 189—
Lichenes arctici collecti æstate, Fellman, 1863.
Herbarium Lichenum Fenniæ, Norrlin et Nylander, 1875-1882.
Lichenes Scandinaviæ Exsiccati, Th. Fries, 1859-1865.
Die Flechten Europas, Hepp, 1853-1867.
Lichenes Helvetici Exsiccati, Schaerer, 1823-1852.
Lichenes Europæi Exsiccati, Rabenhorst, 1855-1879.
Lichenes Sueciæ Exsiccati, Stenhammar, 1860-1865.
Lichens de la Normandie, Malbranche, 1863-1869.
Lichenes Floræ Rossiæ, Elenkin, 1906-1907.
Lichenes Exsiccati circa Cantabrigiam, Larbalestier, 1896.

## DIVISION: *Thallophytes.*

## SUBDIVISION: *Lichenes* (Tournefort) Micheli.

## CLASS: *Ascolichenes* A. Zahlb.

Lichens in which the spores are enclosed in asci.

## SUBCLASS: *Lichenaceæ* Nyl.

Thallus nongelatinous, gonidia heteromerous.

## ORDER: *Gymnocarpales* (Luyken) Fr.

Apothecia open, epithecium visible.

## SUBORDER: *Cyclocarpineæ* Wain.

Apothecia discoid; spores maturing in the asci: no capillitium.

## GROUP: *Radiatæ* Hue.

Thalline structure radially symmetrical; thallus attached to the substratum without rhizoids.

FAMILY: *Usneaceæ* Eschw. System. Lich. 23. 1824.

DIAGNOSIS: Thalline cortex contiguous: cylindrical or angular, bifacial or deformed.
Apothecia lecanorine. Gonidia *Protococcoid.*

DESCRIPTION: Thallus fruticose or filamentous, radial or bifacial; gray, yellow, green, brown or black. Gonidia *Protococcoid.* Apothecia lecanorine (having a thalloid exciple), marginate or emarginate, entire, crenulate or ciliate, disk concolorous, yellow, brown, or black. Spores monoblast, bilocular to muriform—hyaline or colorate.

The *Usneaceæ,* from their size and conspicuous character, are commonly recognized, though often by the laity as mosses. They are represented in all the zones of our area, and are found growing on earth, rocks and trees. Like most lichens, for their highest development they need not only moisture, but abundant light. Economically they possess little practical value, though certain species have been used for food *(Cetraria islandica),* for medicine *(Usnea florida)* and for dyes *(Letharia vulpina).* It is doubtful if they are appreciably injurious to trees. They are evidently very sensitive to atmospheric conditions, and their presence is indicative of pure air, for the partial cleansing of which they are no doubt responsible. As only a few species *(Ramalina, Usnea)* of this family are rock forms, they play little part in the disintegrations which produce soil.[9]

TRIBE: *Usneeæ* Hue Lich. extra Europ. 31. 1899.

Cortical structure complex (decomposed). l. c. 11.28.
Medulla arachnoid.

*(To be continued.)*

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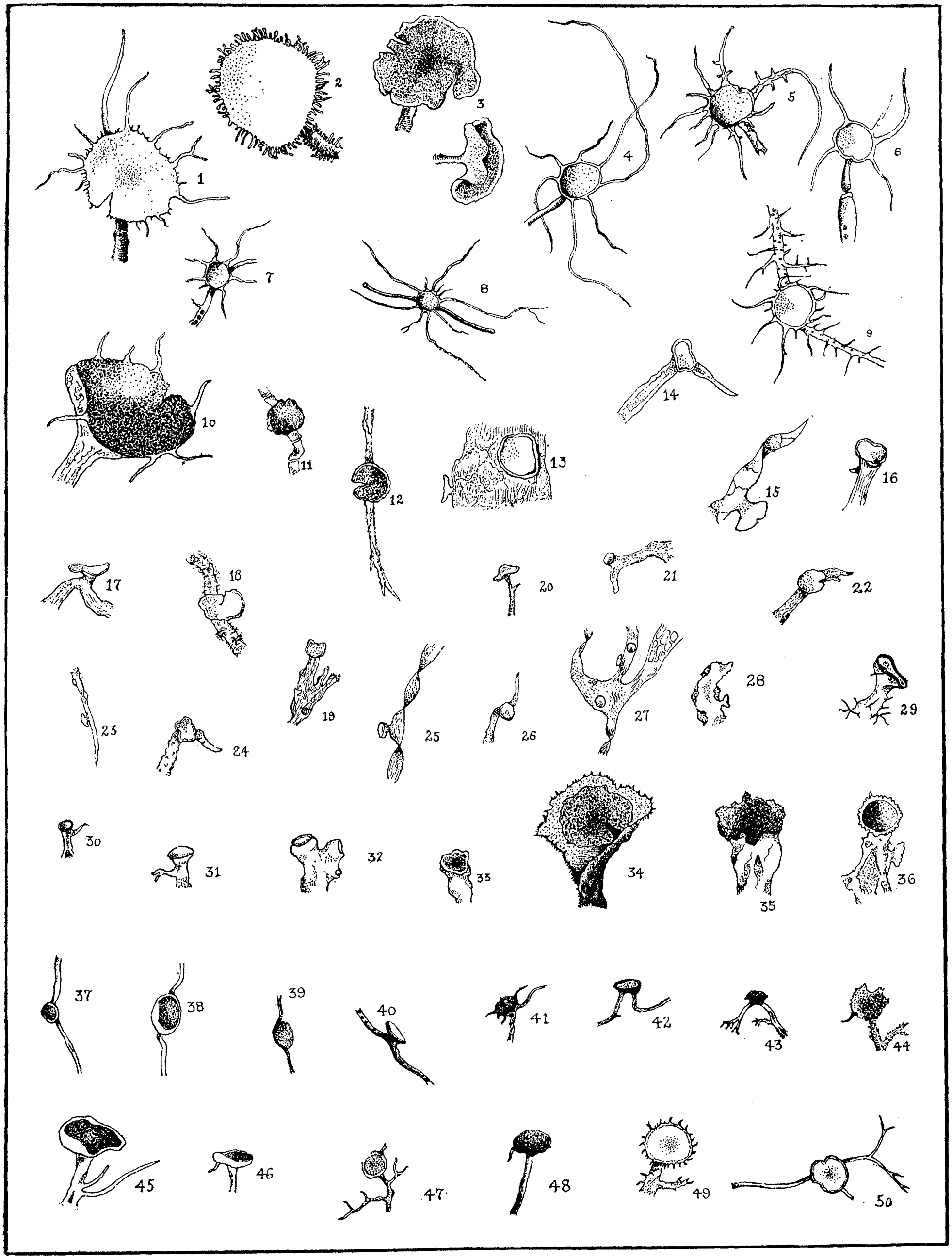
[9] See Herre, Proc. Wash. Acad. **12** : 218. 1910—*Ramalina homalea.*

## EXPLANATION OF PLATE.

1. Usnea florida.
2. “ florida var. strigosa.
3. “ sulphurea.
4. “ longissima.
5. “ angulata.
6. “ barbata.
7. “ cavernosa.
8. “ trichodea.
9. “ plicata.
10. Letharia vulpina.
11. “ divaricata.
12. “ thamnodes.
13. Ramalina fraxinea.
14. “ fastigiata.
15. “ homalea.
16. “ populina.
17. “ calicaris.
18. “ ceruchis.
19. “ polymorpha.
20. “ rigida.
21. “ Duriaei.
22. “ stenospora.
23. “ farinacea.
24. “ complanata.
25. “ usneoides.
26. Ramalina Montagnei.
27. “ reticulata.
28. “ pollinaria.
29. “ crinita.
30. “ dilacerata.
31. “ geniculata.
32. “ pusilla.
33. Dufourea arctica (after Reinke).
34. Cetraria islandica.
35. “ cucullata.
36. “ nivalis.
37. Alectoria sarmentosa var. luteola.
38. “ sarmentosa.
39. “ jubata.
40. “ Fremontii.
41. “ oregana.
42. “ loxensis.
43. Coelocaulon californicum.
44. “ aculeata.
45. Alectoria ochroleuca.
46. “ lata.
47. “ pubescens.
48. “ tristis.
49. Teloschistes chrysophthalmus.
50. “ flavicans.



APOTHECIA OF THE FAMILY USNEACEAE (slightly reduced).